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Estimation of Body Mass from Skeletal Remains

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Abstract:

In the recent time, the anthropology has been developed to the extent where it is able to give the positive and satisfactory result regarding the identification of unknown person. There are many cases where only some skeletal remains or even single bones are found where the anthropologists face the challenges to establish the biological identity. In the identification, the scientist try to find out the age, race, stature, and sex of an individual through the skeletal remains. Now, to narrow down the identity aspect, the body mas has been included in the biological profile. There are very less research available on it but some studies are available play the significant role in the anthropological field. The body mass has the relation with the bones in the form of bone density, shape, size etc. this paper review those studies which worked on the estimation of body mass through skeletal remains.

Keywords: *Body Mass, Skeletal Remains, Biological Profile*

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Introduction

The forensic anthropologist is a specialists that face many challenges during the investigation of mass disaster, genocides etc. The aim of anthropologist is to determine the biological profile of an individuals through their skeletal remains. It proves very helpful when the missing person report, or the description of loved one is present during the match a set of skeletal remains. Through these description or report, numerous biological characteristics are estimated from the skeletal remains such as age, sex, race, stature, broken bones and certain diseases. There are some characteristics which cannot be discerned from the skeletal remains like tattoos, scars and body weight.

The determination of body weight is the most important aspect of biological profile which has not been investigated but there are some studies which shows that the body weight or body mass can be discern the distal humerus and femur measurements. In 1957, Baker and Newman studied and focus on the dry bone weight of the longest bone (femur) and also the entire skeleton to estimate the living body weight. Morse et al felt that the wright of the skeleton and total body weight do not have any relation as the body weight is altered by osteoporosis, prolonged illness and other endocrine disturbances.

In the biological anthropology research, the estimation of body mass through skeletal remains is considered as a vital feature. According to the paleoanthropological and bio archaeological contexts through the estimation of body mass, the biological and behavioral information can be achieved. The motive of the determination of mass is to find out the environment and evolutionary significance of differences among peoples living at different places and in different times.

Now these days, body mass has become an area of interest in modern forensic identification as well as multiple fatality investigations because of its conspicuous individualizing feature and give significant influence on taphonomic processes. The main area to estimate the body mass is post cranium. There are two main and broad approaches; mechanical approach and morphometric approach. In the mechanical methods, the relationship is seen between the body mass and the skeletal remains which bear the weight of the body for example femur. The femoral head breadth are used for this purpose. There are three different regression equations find through the femoral head breath which are based on the known or estimated body masses. But these equations are not applicable to European population. While in case of morphometric methods, the body mass is measured/ estimated through the construction of body shape from the stature and bi-iliac breadth. The morphometric technique are used to numerous archeological and paleontological specimens. The main advantage of this stature/biiliac method is that it does not depend on the assumed persistent mechanical relationship exist between body mass and articular size. The femoral head size relation with body mass have different formulae for different population. The next issue is that the femoral head size equations were derived through only the limited population whereas the stature/biiliaa method is the result of large population. In spite of having more advantages, the stature/biiliac method has disadvantage as it needs more skeletal elements, a complete pelvis.

In case of fossil hominins, the mass is estimated through the interspecies analyses. In which inverse regression of body mass on skeletal dimensions methods are used.

Bone Cellular Composition and their Action

There are two types of bones cells which contribute in the bone resorption and bone formation. The bone cell that help in the bone resorption is called osteoclast. The resorption through the osteoclast takes place in both condition during the bone growth and repair and the destruction of bones. The bone cells that help in bone formation is called the osteoblast. The main function of these bones cells is to form the organic part of the bone matrix, called osteoid.

In the skeletal system, there are two types of morphological changes; modeling and remodeling. In the modeling, osteoclast and osteoblast work independently to change the size and shape of the bone. They occur at childhood growth and development. The modeling is continuous and prolonged process. Modeling is defined as the addition of new bricks to the wall for making it heighten and thicken. While in the remodeling, the osteoclast and osteoblast coupled together in basic multicellular units or BMUs. They do not affect the shape and size of the bone. The remodeling live throughout the life of person.

Body Mass

In the consideration of body mass, there is necessary to explore the load bearing and bone strength. Here, bone strength can be defined into two terms bone quality and biomechanical properties. To study the biomechanical properties the cross-sectional geometry of long bone is used. Bone quality is also called the bone density (synonyms). Bone density shows the age, sex, lifetime activity levels, genetics, nutrition and body mass.

Body mass can be categorized into two vital components; body fat (which stores energy) and lean mass (muscle, organs and bone). These components have distinct biological significance separately and different selective pressure during human evolution. Compare to the other primates and mammals, the humans have high proportion of body fat. While the skeletal mass is low compare to the closest relatives Pan and other primates.

The estimation of fat and lean mass through skeletal remains characteristics help to investigate the past human adaptation, health, evolution and also in the understanding of contemporary variation's origins in body composition. Before the femoral head measurements, there were many attempts to estimate the muscle area in relation the cross-sectional characteristics of bones at one body location, not with the total skeletal muscle or lean mass and produced mixed result. In 2010, Shaw stated that cross-sectional geometry of bone is the poor predicator of muscle area which is present at the same cross-sectional location especially for the humerus, tibia, and ulna of adult.

Other than the femoral head measurements and stature/biiliac method, the recent studies has been done for the estimation of body mass through computer tomography and cross sectional geometry by which skeletal robusticity can be investigated through cortical bone thickness. But the computed tomography is conducted as standard procedure and cross sectional geometry cannot be calculated, so these are less reliable for the estimation of body mass. The computed tomography technology along with the other 3-dimensional imaging techniques such as surface laser scanning and photogrammetry are use in the estimation of fossil mass in the field of paleontology.

Review of Literature

Robbins, Sciulli and Blatt (2010), studied the relation between body mass and sub adult skeletal remains. They stated that there are two method for the estimation of body mass in sub adults; width of distal femur metaphysis in individual's age from 1 to 12 years and the second method is the femoral head for sub adults. For generating the formulae, midshaft femur cross-sectional geometry data through Denver Growth Study were used. The precision of these formulae were same as the previously used sample based on the femoral head breadths and femoral distal metaphyseal. In case of sub adult, where the bone ends are damaged and unavailable, the midshaft are used to stimate the body mass. But in case of older age (9-17), the midshaft method is less accurate and precise for the estimation of body mass, hence femoral head is used. So, the use of bone area, the age matters.

Pomeroy, Macintosh and Wells (2017), proposed that body mass can be estimated through its components (lean and fat mass). But methods which are used for the estimation of body mass, are poorly developed. In their conclusion, they stated that the lean and body mass can be discerned from the cross-sectional properties of long bone in adults. There are case like western reference samples, where the cross-sectional properties of shaft are affected by age, activity and hormonal status.

Pomeroy *et al* (2018), compare the lean mass with body mass and concluded that the lean mass can be estimated with less error compare to the body mass, while the estimation of fat mass is difficult rather than others. According to them, femoral head diameter are not able to estimate the body mass while the lean mass and bone properties are linked though the forces created by the muscles, developmental factors lies between lean mass and bone.

According to Ruff (2007), the body mass and stature can be estimated from the skeletal remains of juvenile through the use of subset of the Denver Growth Study sample. They contain the error but equal or smaller than the adult formulae. From their study, they concluded that the femoral distal metaphyseal breadth is appropriate for the estimation of body mass in children while femoral head breadth are for older children and adolescents. They also observed that the estimation error increase with the increase in age, especially the mid-adolescence show large error. In adolescents, the pelvis bi-iliac breadth are used to estimate the body mass.

Elliott *et al* (2015) concluded that the existing equations for the estimation of body mass from post

cranium requires the attention and carefulness. The existing equation such as the equation from morphometric covering stature bi-iliac breadth are not more reliable than the mechanical/ femoral head breadth equations. The femoral head breadth give positive and neutral effect on estimation accuracy. In the end of the paper they suggested that there is need to evaluate the current methods of post cranial body mass estimation and applied more carefully than applied in biological anthropology. This issue can be resolved

Conclusion

From the review of many research papers, this paper concluded that the body mass which is an important biological profile feature, can be estimated through skeletal remains. For this, many methods have been developed such as cross-sectional geometry of bone, computed tomography, femoral head breath method, stature/biiliac method etc. but all these methods have some disadvantages. In spite of having some disadvantages, the anthropologists use femoral head measurement and stature/biiliac method because of the lack of availability of knowledge regarding the relation between skeletal remains and body mass. So, there is need of more study in the field of body mass estimation through which anthropologist can narrow down their search about the identification of an unknown person through their skeletal remains.

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